Chapter 12

FIELD WORK

Introduction

Fieldwork is always needed to provide accurate base data for plan development. This base data is compiled from several data sources including existing plans, maps and land survey descriptions. Without accurate and timely data to base project designs on, it is almost impossible to effectively and efficiently design projects. The primary source for the designer to obtain accurate data is topographic ground survey. It is, however, essential the designer review the project in the field to fully comprehend the correlation between the plan and section representation and the actual field conditions. This helps to avoid missing or misinterpreting the context of the surrounding area and how that should be considered within the elements of the proposed design. Fieldwork also includes geotechnical investigations and design team field checks.

Other techniques for acquiring information about the project site involve aerial survey, aerial photography, photogrammetric mapping, GPS mapping, and subsurface investigations. These techniques are briefly described in this chapter, the emphasis being on field surveys obtained by conventional field methods.

The *Survey Manual* (2) adopted by the NHDOT outlines procedures to be used by the Survey Section of the Bureau of Highway Design. The designer should have a general knowledge of the contents to better understand the practical work of field surveying.

Field Survey

Responsibility

The Chief of Design Services is in charge of a number of Survey Area Supervisors who in turn supervise a number of field survey crews. The Chief of Design Services is directly responsible for the work of all survey crews. All requests for survey work must be directed to, and authorized by, the Chief of Design Services.

Survey work is expensive, time consuming, and places personnel in close proximity to traffic. It is the responsibility of the highway (or bridge) designer to limit the requested survey information to that which is necessary to properly complete the design.

Base Data

Base data may include the following:

- Photogrammetric mapping tied to the State Plane Coordinate System
- Aerial photographs and/or old project plans indicating the survey requirements

- U. S. Geological Survey Quadrangle sheets
- Traverse lines tied to the State Plane Coordinate System
- Verbal and written instructions
- Major property line information on plats or subdivision plans, and Town or City utility plans showing manhole locations, hydrant locations, and other visible features.

Horizontal Control

The New Hampshire State Plane Coordinate System of 1983 is utilized on all NHDOT projects. The advantages of using the State Plane Coordinate System are:

- All control surveys are on a single datum, and thus the relationship of one survey to others is established.
- All subsequent surveys can originate and close at stations of known position and reliability. Therefore, the reliability of the new survey can be easily determined and adjusted, if necessary.
- With GPS technology, points can be readily reestablished if geodetic monuments are unavailable.
- Route surveys can be started at various points along the route with assurance that the survey sections will "fit."

The datum must be noted appropriately on all plans.

Vertical Control

Elevations of all Geodetic Monuments and the subsequent traverse points are relative to National Geodetic Vertical Datum of 1929 (NGVD29) or to the North American Vertical Datum of 1988 (NAVD88). The datum used must be noted on all plans.

Types of Survey

Preliminary Surveys

Preliminary surveys are defined as any survey work performed prior to advertising the project for construction. This includes primary traverse and complete 3 dimensional topographic coverage of the project area. Particular attention must be given to all details underground, on the surface, or overhead, which may in any way affect the location of the proposed improvements.

The purpose of the preliminary survey is to facilitate the preparation of preliminary plans. When the project scope is fully established, the preliminary survey can be a complete contract plans survey.

Prior to entry onto any private property, Right-to-Enter letters are sent Registered Mail to all property owners within the project area. These property owners will be given ten (10)

working days to respond to these letters once they have been sent from NHDOT Headquarters.

When information from old plans is either outdated or is insufficient to provide the necessary project plan coverage, the Preliminary Design or Final Design Section of the Bureau of Highway Design requests new survey. Some projects of limited scope such as, but not limited to, guardrail replacement and pavement rehabilitation, may utilize existing plans or basic field data that result in simplified plan "sketches" without full survey. The essential data pertinent to the intent of the project is verified and/or located in the field by the Design personnel. Photographs and videos are of particular value as they provide additional reference material and often avoid additional field reconnaissance. They also provide a visual record of the existing preconstruction condition.

With the advent of computer aided design and drafting (CAD/D) and Total Station/Data Recorder surveying technology, the need to return to the project area is less likely than in the past. The preliminary survey covers a wide area and includes river grids, drainage outfalls and channels, wetland delineation and information around structures that may be necessary for quantity calculations. In some instances, the survey crew is not required to return to the project area until the proposed construction line layout is requested for geotechnical investigation or expanded survey is required. There are often times when additional detail is required due to new site developments within the project limits that alter curb lines, change drainage, and modify slope conditions, etc. These alterations prior to construction must be surveyed and included in the electronic model as "existing conditions" so that the contract quantities are as accurate as possible.

Profiles, cross-sections and river grids are all produced electronically, with rare exception, based on the surveyed information. If any alignment changes are necessary, adjustments are made using the CAD/D system, and new profiles, cross-sections and grids are produced. Preliminary Design's Plan Prep section is responsible for developing the ground model based upon the survey information gathered. If there are any inconsistencies, the Survey Area Supervisor is contacted to resolve the issue(s).

Construction Surveys

Construction surveys are those surveys completed after advertising. Though they are no longer common practice, surveys following completion of construction are sometimes requested in conjunction with final audit to determine final quantities of certain pay items and to show the as-built location of the improvements made as part of the project. As a minimum, the Contract Administrator shall request that survey be completed to accurately locate bounds constructed as part of the project for accurate record of the right-of-way.

Computations

The Survey Section is responsible for computing the closure of horizontal traverses and adjusting bench runs before turning them over to the design teams. Computations and

adjustments are made by computer. The original computations are retained in CAD/D for use throughout the duration of the project.

Plotting

The Plan Prep Section of Preliminary Design plots detail and topography using information from Survey.

Field books are used as a guide for Plan Prep to produce an accurate computer ground model. Any questions regarding the information to be shown should be resolved before proceeding with plotting. Field books are hard copy notebooks of the survey information gathered by a survey crew. The survey crews are required to log the date, weather, each member of the survey party and their duties at the start of each days work. The field books also allow the survey crew to make notes regarding specific details of the survey.

Field books should indicate the reference traverse used for the topographic locations. All traverse points are normally shown on the plan. The Survey Section will make every effort to number the traverse points so as not to duplicate point numbers.

Standard graphic symbols and standard drafting practices are used to provide consistency in the preparation of plans. Standard abbreviations and symbols used in field survey books are illustrated in the *Survey Manual* (2).

Other Field Information

Land Boundaries

Land boundary markers may have legal, as well as historical, significance. Both considerations should be recognized. Surveyors are instructed to record the markings on monuments and designers must be aware that their plans should show the location accurately. The Commissioner is responsible for making policy decisions concerning reestablishment of monuments, or dealing with historical markers.

Legal

Boundary markers established by public surveyors must not be moved without authority of the NHDOT. Surveyors of the NHDOT locate boundary markers and reference them for later re-establishment if necessary (RSA 572.25). Government benchmarks, triangulation monuments or officially set landlines of public surveys must be referenced or replaced. This must be coordinated with the responsible authority.

Historical

Old, well-established landmarks may have historical significance and must be identified as a potential environmental consideration. The marker or landmark may be a granite survey bound, stone, heavy iron stake or historic tree. The DOT's Environmental Coordinator and the historical society for the project area should be contacted early and

surveyors should be alerted if there are any known or suspected historical landmarks within the project area.

Bridge Sites

The Bureau of Bridge Design is typically responsible for requesting information for bridge site(s) or for major drainage hydrographic surveys. Waterway openings at bridges as well as major drainage structures are always given special consideration by the survey crews.

High-Water Marks

Survey crews should note the presence of debris piles or wash within the project limits. When warranted, nearby property owners are contacted to obtain frequency information. Many times, the reported frequency will coincide with major storms of record. This is useful information for the drainage designer. Significant erosion or washouts are always noted and reported.

Boring Locations

The locations of subsurface explorations (test borings and test pits), both proposed and actual, are recorded in the field notes. Although the designer will refer to the recommendations in the Geotechnical Report (prepared by the Bureau of Materials and Research), the designer may need to refer to the field notes occasionally to check ground elevations to compare with the subsurface exploration logs. The subsurface exploration records are loose-leaf field notes kept in survey files. A duplicate of these records is filed with the Bureau of Materials and Research.

Aerial Survey

Aerial surveys performed by others for use by the NHDOT consist of enlarged photographs or photogrammetric mapping to be used for preliminary and or final design purposes.

There are a number of combinations of aerial photographs and maps, which can be used by the designer. In all cases, there are limitations to the accuracy that should be recognized. In particular, enlarged, uncontrolled photographs are less distorted in the center. However, all original distortion is magnified. The enlargement sometimes gives the designer scale confidence that is not justified.

Another significant limitation of aerial survey is the density of vegetative cover. This is of particular concern in areas with coniferous vegetation. The areas where deciduous vegetation is prevalent can often be worked around by performing the flights during late fall/ early winter, prior to snowfall, when the leaves have fallen and no longer obscure the ground.

There are however, significant advantages to using aerial enlargements, especially from a preliminary design standpoint. For example, the area of interest can be determined with

reasonable accuracy from photographs and this information (embellished) can be used as a location map for presentations or as a mark-up to request more accurate ground survey.

Accuracy

When dealing with photogrammetrically prepared, plannimetric or topographic maps, the designer should be aware of the accuracy to be expected. The Department has established two sets of specifications for photogrammetric mapping. The criteria for the *Planning* level specification are the national mapping standards and are listed below in Table A. The *Engineering* specification requires the information to be processed at a much tighter control. This requires extensive ground control set by the Department's Geodetic Section. The specific criteria is listed below in Table B:

TABLE A

Contours	90 percent of solid-line contours will be 1/2 a contour interval from true elevation. 10 percent may not be in error more than one contour interval.
Spot Elevations	90 percent within 1/4 contour interval, 10 percent within 1/2 contour interval.
Coordinate Grids	All grid coordinates will be within 0.01 inches (0.25 mm) of true value.
Planimetry	90 percent of all well-defined objects (on photographs) will be positioned to 0.025 inches (0.625 mm) of their true position. No feature will be misplaced by more than 0.05 inches (1.25 mm) from true coordinates position.

TABLE B

2.5 in or less (62 mm)	**Transportation Surfaces –** This category includes features such as paved or unpaved roads, shoulders, parking lots and driveways, as well as curbs, bridges, retaining walls and sidewalks.
5 in or less (125 mm)	**Engineering Surfaces/Drainage –** This category includes features such as roadway embankments, drainage ditches, water-body edges, lawns and areas within 60 ft (20 m) of the edge of pavement.
10 in or less (250 mm)	**Other Surfaces –** Non-engineered surfaces and areas over 60 ft (20 m) from the edge of pavement.

Subsurface Investigation

Underground information, at best, is the educated assumption of trained geologists or engineers based upon state-of-the-art technology. The designer should accept the

findings with the understanding that the information is the best obtainable, given the obvious limitations.

Underground utility information with visible surface evidence (e.g. manholes, water shutoffs) should be accepted but critical locations may need to be uncovered (potholed) by the utility company and positively located by the survey crew. Subsurface Utility Engineering (S.U.E.) may be utilized by the Department to more accurately locate existing underground utility facilities but still requires positive location of the facilities by survey crews. This process involves several different methods for obtaining existing underground utility information. The four quality levels of utility depiction as described in the American Society of Civil Engineers *CI/ASCE 38-02, Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data* (1) are listed below:

> *Quality Level D* - Typically referred to as "records research," this level provides information that has been obtained from existing records
>
> *Quality Level C* - This level adds field survey of visible, aboveground utility facilities such as valves, fire hydrants, manholes, etc., reconciled to existing utility records
>
> *Quality Level B* - This level involves using surface geophysical prospecting techniques to determine the existence and horizontal position of underground utilities.
>
> *Quality Level A* - This level is the highest level of accuracy and generally uses vacuum excavation equipment at critical points to determine the precise horizontal and vertical position of the underground utilities.

The use of quality levels allows engineers and project owners to certify on the plans that a certain level of accuracy has been provided. All four quality levels may be used on large projects, depending on the level of accuracy necessary at utility conflict points.

Reconnaissance

As explained briefly in Chapter 2, Project Development, personnel from the Bureau of Materials and Research or geotechnical consultants engaged by the Department perform reconnaissance geotechnical surveys. This type of visual inspection is sometimes supplemented by selected subsurface exploration. There are occasions when muck or bedrock locations, or potential locations, are identified by the designer and should be discussed with the Supervisor. If these conditions could influence the design, impacts on adjoining properties, environmental resources, traffic control, or other significant design constraints, a preliminary reconnaissance by the Bureau of Materials and Research should be requested.

If subsurface exploration is required, it is normally requested during the Preliminary Design phase of project development. The latest available plans, profiles and cross-sections are forwarded with this request. The designer should be aware of any visual cues such as the presence of wetlands, cracks in slopes, etc. and should always question suspicious geotechnical conditions.

Subsurface Exploration

Subsurface exploration for highway construction is accomplished with soil augers, rock cores, auger drill rigs and backhoes. The type of exploration to be performed is determined by the Bureau of Materials and Research after evaluating the geological strata and project characteristics.

Rock coring or auger drilling is used for bridge foundation exploration but, again, the Bureau of Materials and Research determines the method of exploration.

Note: Any request for subsurface exploration must be coordinated with the Chief of Design Services and Dig Safe to prevent situations due to the presence of underground utilities. Standard practice is to prepare a plan accompanied by a letter from the Chief of Design Services to the Bureau of Materials and Research listing the utilities known to have facilities in the area. The Bureau of Environment should also be coordinated with to avoid any natural resources or to take precautions for any known or potential HAZMAT issues.

References:

1. American Society of Civil Engineers (ASCE), CI/ASCE 38-02, *Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data*, ASCE, 1801 Alexander Bell Drive, Reston, Virginia, 2003.

2. New Hampshire Department of Public Works and Highways, *Survey Manual*, NHDOT, 7 Hazen Drive, Concord, New Hampshire, July 1972.